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Digital development

Report of the Secretary-General

Executive summary

This report discusses digital development by analysing emerging changes in the digital development landscape with regard to digital technologies, digital demographics and development priorities. Special focus is given to television (TV) white space applications, next-generation satellites and the emergence of "millennials". The transformative impacts of these changes on our society are discussed. The report highlights the need to broaden the current discourse on information and communications technologies for development (ICT4D) and identifies four policy focus areas for facilitating effective digital development: the digital ecosystem, digital inclusion, digital sustainability and digital threats. Findings and policy suggestions in the context of the emerging post-2015 development agenda are provided.

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Introduction

1. The Commission on Science and Technology for Development at its seventeenth session, which took place in May 2014, chose "digital development" as one of the priority themes for its eighteenth session. It also decided that in addressing this theme, special attention should be given to millennials,[1] emerging technologies of white space applications and next-generation satellites.

2. To contribute to a better understanding of this theme and assist the Commission in its deliberations at its eighteenth session, the Commission secretariat convened a panel meeting in Geneva from 26–28 November 2014. This report is based on the findings of the panel, national briefings made by members of the Commission and other relevant literature.

3. Section I of the report describes the changing landscape of digital development in terms of emerging technologies, changing demographics and development priorities. Section II discusses the transformative impacts rendered by these changes in two sectors of the society, namely, the economy and politics. Section III discussing the implications of these changes for development and policymaking. Section IV highlights key findings and suggestions.

I. A changing digital development landscape

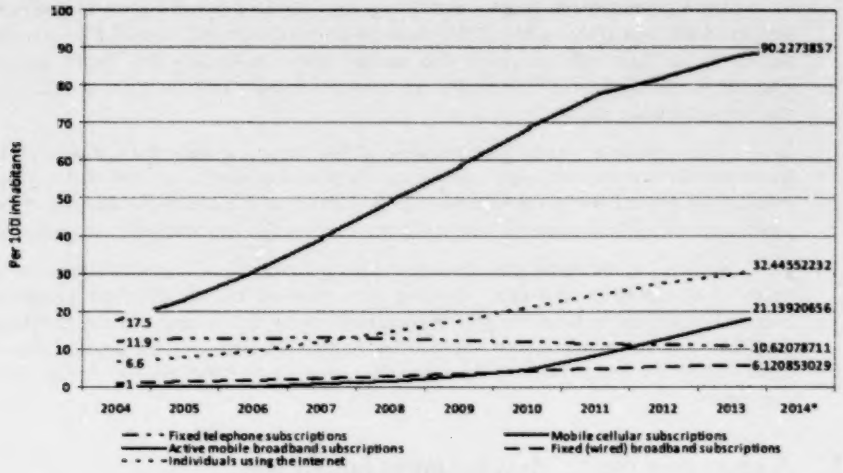
4. Since early 2000, the digital development landscape has changed in three significant, foundational areas: digital technologies, demographics and development priorities. This section examines these changes.

A. Changing digital technologies

5. Information and communications technology (ICT) has changed dramatically during the twenty-first century. Major ICT trends in developing countries are summarized in figure 1 below, which shows that mobile, broadband and mobile broadband (hence smartphones and tablets) will be a key driving force of future technology trends in ICTs. These figures smooth over many inequalities, which will be discussed later, but the overall change is clear: in 10 years, digital ICTs have moved from a peripheral role to a core role in our daily lives. Even in developing countries, they have increased their presence in terms of their reach, scope and depth. As a result, the existence of a digital "nervous system" for development is already beginning to appear: a pervasive digital infrastructure in which most development organizations, from international agencies to government departments and small community-based organizations, have Internet access and in which a large proportion of individuals in developing countries have digital mobile phone access.

[1] The term "millennials" refers to those who are born after 1980, the first generation to come of age in the new millennium.

Figure 1
Key information and communications technology indicators for developing countries, 2004–2014



Source: ITU World Telecommunication/ICT indicators database.

* Estimate

6. During its 2013–2014 intersessional period, the Commission highlighted five major emerging trends in digital technology: datafication, big data, cloud computing, the Internet of things, and smart systems (E/CN.16/2014/3). These trends are profoundly changing the digital development landscape. One of the observations made by the Commission was that harnessing their potential would require reliable, high-quality infrastructure. It is in this context that an analysis is made of two emerging technologies -TV white space and next-generation small satellites– that hold the potential to strengthen the ICT infrastructure, especially in developing countries.

Applications of television white space

7. Different radio frequencies are assigned or licensed by national and international regulatory bodies for specific purposes. The assignment of frequency bands leaves white space between allotted frequencies, which essentially forms a type of momentarily unused spectrum. Such unused spectrum is also the result of technical changes, such as the shift to digital television technology. Experiments and pilot projects are currently being carried out to use such white space for several applications, such as enabling broadband Internet connectivity, especially in rural areas.

Potential of white space applications

8. Especially in developing countries, one of the most widely experimented applications of white space technology has been to promote broadband Internet access to rural areas. Rural areas are often characterized by difficult terrain and are disconnected from the local power grid. White space power stations are set up to be charged with solar panels. Very high or ultra-high frequency[2] spectrum used in white space technology offers

[2] Commonly known by the acronyms VHF and UHF, respectively.

10 times the coverage of the traditional Wi-Fi spectrum with the same transmit power and promises higher penetration.[3] Hence, it is particularly suited to the difficult terrain that characterizes underserved rural areas; white space power stations are also set up to be charged with solar panels.

9. In addition to rural Wi-Fi, TV white space can also be effective during disaster response by creating an emergency broadband infrastructure. Further, when combined with effective automated devices, white space applications can be used to develop a system for environmental monitoring, including measuring pollution level, oil spills and intensity of climatic events, and issuing timely warnings. Other applications include border protection and monitoring of critical infrastructure such as power plants. They have the potential to facilitate a whole array of "smart city" applications and generate jobs directly and indirectly. By increasing the number of Internet service providers and people employed in the manufacturing of TV white-space-enabling instruments, new job opportunities are created. At the same time, the availability of broadband Internet in previously unserved areas could result in new establishments and business models that generate jobs indirectly. Several pilot projects related to TV white space applications are currently under way in several developing countries.[4] Most of them have been successful in connecting local schools, universities and similar public infrastructure, as well as providing broadband Internet connectivity to previously unserved rural communities.

Next-generation small satellites

10. Another emerging telecommunication technology is that of next-generation small satellites, such as nanosatellites and picosatellites, which are relatively fast to develop, and inexpensive to build and launch. These satellites weigh from 1–10 kg, have an edge length of less than 30 cm and a typical mission lifespan of less than three years.[5]

Potential of small satellites

11. These small satellites are bringing space into everyday life. They offer greater individualized satellite access for entertainment and education, and a myriad of practical applications such as weather forecasting, earth observation, climate change adaptation and mitigation, forest fire detection and monitoring, remote sensing and communication.[6] Advancements in electronics and instrumentation have increased the capabilities of smaller satellites, making them increasingly comparable to that of their larger and more expensive counterparts.

12. Small satellites open up an easy access route to space to a large number of developing countries. By engaging in small satellite development and deployment developing countries can build their technological capabilities related to space technology. These capabilities can in turn be used to develop and adapt satellite technology applications to deal effectively with specific local problems related to issues such as rural connectivity,

[3] A Mody, 2014, presentation made at the 2014–2015 Intersessional Panel meeting of the Commission on Science and Technology for Development, held in Geneva in November.

[4] For details on white space pilot trials, see http://research.microsoft.com/en-us/projects/spectrum/pilots.aspx, accessed 18 February 2015.

[5] M Buscher and K Briess, 2014, Analysis of Regulatory Challenges for Small Satellite Developers Based on the TUB Small Satellite Database, presentation given at the International Telecommunication Union (ITU) workshop on the efficient use of the spectrum/orbit resource, Limassol, Cyprus, 14–16 April.

[6] P Platzer, 2013, Nanosatellites will give everyone access to space, Techonomy, 8 November, available at http://techonomy.com/2013/11/nanosatellites-will-give-everyone-access-space/, accessed 18 February 2015.

deforestation monitoring, crisis management and famine detection. Many university students, including undergraduate students from developing countries, are currently engaged in developing these microsatellites. Also, several private sector firms are launching microsatellites with specific commercial applications.

13. These emerging digital technologies require an enabling environment for their wide-scale adoption. An enabling environment includes, inter alia, appropriate licensing mechanisms to conduct pilot projects, clarity in terms of regulations and awareness about the potential of these technologies. The first step in this direction would be to ensure that these new technologies do not create interference with established technologies. For instance, the usage of TV white space should not interfere with the primary usage of TV spectrums for transmitting television channels. Likewise, small satellites should be deployed and used in such a way that they do not create an obstruction to existing satellite infrastructure or violate international regulations governing them.[7] This would entail policy and regulatory intervention by governments and relevant international organizations. Inertia from regulators can hinder the adoption and promotion of these technologies.

14. Thanks to these advances in telecommunications, the blank spaces on the digital map are gradually being erased, and there is a transition towards being connected everywhere at all times. There is a still a long way to go, but within a generation almost everyone will be connected, and it is likely that full connectivity will gradually become a reality.

B. Changing digital demographics

15. The technology changes outlined above have been accompanied with changes in demographics of ICT usage. The geographic composition of Internet users has changed, indicating significant progress in the bridging of the global digital divide in terms of access.[8] Geographically, in terms of number of users, the "new Internet world" (emerging nations of the global East and South) have already surpassed the "old Internet world" (the United States and Europe).[9] There are now twice as many Chinese citizens online as there are United States citizens in total; the Middle East and Africa have more users than Western Europe.[10] Some argue that ICTs are more central to the lives of these new Internet world users and that the latter are more sociable online, produce more online content and source more of their audio-visual content online.[11]

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[7] Y Henri, 2014, Current Satellite Regulatory Issues, and T Azzarelli, 2014, International Regulations for Nano/Pico Satellites, presentations given at the ITU workshop on the efficient use of the spectrum/orbit resource, Limassol, Cyprus, 14–16 April.

[8] G Bolsover, W H Dutton, G Law and A Dutta, 2014, China and the US [United States of America] in the new Internet world: A comparative perspective, in *Society and the Internet: How Networks of Information and Communication are Changing Our Lives*, M Graham and W H Dutton, eds, Oxford University Press, Oxford, United Kingdom of Great Britain and Northern Ireland, 117–134.

[9] Ibid.

[10] Internet Live Stats, 2014, Internet Users by Country (2014), available at http://www.internetlivestats.com/internet-users-by-country/, accessed 18 February 2015; Internet World Stats, 2014, Usage and Population Statistics, available at http://www.internetworldstats.com/stats.htm, accessed 18 February 2015.

[11] Bolsover et al., 2014, op. cit.

Emergence of millennials or digital natives

16. A large share of the newer Internet users is represented by the "growing up digital" generation.[12] "Digital natives" can be defined as those 15–24 year olds with five or more years of online experience.[13] They are more likely than others to consume and produce online content, and perceive themselves as being more innovative and creative; what is more, ICTs are changing the way they think and learn.[14] While only around one fifth of the youth cohort in developing countries are digital natives, compared with four fifths in the global North, youth in the global South are twice as likely to be digital natives as the total population, so they have a disproportionate role that might be worth specific encouragement.[15]

17. As mentioned previously, the term "millennials" refers to a larger age cohort of those who are born after 1980, essentially the first generation to come of age in the new millennium.[16] This is the generation to follow Generation X, and according to recent estimates, would comprise 75 per cent of the global work force by 2025.[17] A distinguishing feature of this generation is that they are the first growing up digital generation. The bulk of their activity, including peer-to-peer communication and knowledge management, is mediated by digital technologies.[18] Given that they make proportionately greater use of digital technologies and social networks than other categories, the engagement of these digital natives – for example in education or politics – may be enhanced by ensuring effective digital channels in these sectors. ICT opens up innovative ways to deliver education to the younger generation. Further, ICT has a major role to play in facilitating collaboration and partnerships between the millennials of the global North and South, and among the millennials within these regions as they seek effective solutions to developmental problems.

18. Yet access to ICT alone does not guarantee reaping its full benefits. It is necessary to climb up the digital "role ladder",[19] that is to say, to make the transition from being active users of e-mail and Internet applications to becoming producers, entrepreneurs and innovators, taking advantage of ICT-enabled opportunities. Climbing up this ladder would

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[12] D Tapscott, 1998, *Growing Up Digital: The Rise of the Net Generation*, McGraw-Hill, New York, United States.

[13] ITU, 2013, *Measuring the Information Society 2013*, ITU, Geneva, available at http://www.itu.int/en/ITU-D/Statistics/Pages/publications/mis2013.aspx, accessed 18 February 2015.

[14] J Lehrer, 2010, Our cluttered minds, *The New York Times*, 3 June, available at http://www.nytimes.com/2010/06/06/books/review/Lehrer-t.html, accessed 18 February 2015; G Blank and W H Dutton, 2014, Next Generation Internet Users: A New Digital Divide, in *Society and the Internet: How Networks of Information and Communication are Changing Our Lives*, M Graham and W H Dutton, eds, Oxford University Press, Oxford, United Kingdom, 36–52; *The Economist*, 2014, Briefing: The staid young, 12 July.

[15] ITU, 2013, op. cit.

[16] Pew Research Center, 2010, Millenials: A Portrait of Generation Next, February, available at http://www.pewresearch.org/millennials/, accessed 19 February 2015.

[17] Deloitte, 2014, *The Deloitte Millenial Survey 2014: Big Demands and High Expectations*.

[18] Francesc Pedró, 2006, The new millennium learners: Challenging our views on ICT and learning, Centre for Educational Research and Innovation, Organization for Economic Cooperation and Development (OECD), available at http://www.oecd.org/edu/ceri/38358359.pdf, accessed 19 February 2015.

[19] R Heeks, 2014, *ICTs and Poverty Eradication: Comparing Economic, Livelihoods and Capabilities Models*, Development Informatics Working Paper No. 58, Institute for Development Policy and Management (IDPM), University of Manchester, United Kingdom, available at http://www.seed.manchester.ac.uk/subjects/idpm/research/publications/wp/di/, accessed 19 February 2015.

require the development of capabilities – technological and other skills such as critical and analytical thinking, problem solving and creativity. Although there is a surge in the number of millennials from developing countries who are active Internet users, very few end up climbing up the role ladder to become producers, entrepreneurs or innovators, as they lack the necessary digital capabilities and enabling opportunities. This highlights the urgent need for a capabilities-based approach to ICT capacity-building, especially in developing countries.

C. Changing development priorities

19. The current ICT4D discourse, including the two World Summits on the Information Society in 2003 and 2005, were significantly shaped by the Millennium Development Goals. This approach focused largely on mitigating social deprivation. The Declaration of Principles[20] adopted in Geneva at the World Summit on the Information Society in 2003 proclaimed that "our challenge is to harness the potential of ICT to promote the development goals of the Millennium Declaration" and recognized ICTs as "tools" to achieve development goals. These development priorities that shaped the current ICT4D discussion have also evolved since the early 2000s. The Rio+20 Conference of 2012 called for a set of sustainable development goals that encompasses three dimensions of sustainable development: economic, social and environmental. These goals will be part of a post-2015 development agenda envisaged to be strong, ambitious, inclusive and people centred.[21] Three core themes in development can be identified from the emerging post-2015 development agenda discussions:[22]

(a) Transformation: It is clear that "business as usual" would not deliver on the ambitious post-2015 development agenda. There has been a call for a paradigm shift in the development approach that is truly transformative;[23]

(b) Inclusion: The development process should ensure equal opportunities – that all people, regardless of their background, can achieve their full potential in life. Such efforts include policies and actions that promote equal access to public services and enable citizens' participation in the decision-making processes that affect their lives;[24]

(c) Sustainability: "[d]evelopment that meets the needs of the present without compromising the ability of future generations to meet their own needs".[25]

20. The subsequent sections of this report show the intricate linkages between ICT and the three core themes of the post-2015 development agenda. Further, ICT also plays a

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[20] WSIS-03/GENEVA/DOC/4-E.

[21] E/2014/L.22–E/HLPF/2014/L.3.

[22] R Heeks, 2014, *From the MDGs to the post-2015 agenda: Analysing changing development priorities*, Development Informatics Working Paper No. 56, IDPM, University of Manchester, United Kingdom, available at: http://www.seed.manchester.ac.uk/medialibrary/IDPM/working_papers/di/di_wp56.pdf, accessed 19 February 2015.

[23] One year on: An open letter from former members of the UN [United Nations] Secretary-General's High-Level Panel of Eminent Persons on the Post-2015 Agenda, 22 September 2014, available at http://www.un.org/sg/management/pdf/HLP_2015_open_letter_sept_2014.pdf, accessed 19 February 2015.

[24] Working definition of social inclusion from the Department of Economic and Social Affairs; see http://undesadspd.org/socialintegration/definition.aspx, accessed 19 February 2015.

[25] World Commission on Environment and Development, 1987, *Our Common Future*, Oxford University Press, Oxford, United Kingdom.

crucial role in shaping the development agenda by providing space and opportunity for wider consultations. During the conception of the Millennium Development Goals, the international community was only beginning to understand the "catalytic potential of ICTs to advance development agendas and priorities". Further, it is necessary to recognize ICT as "cross-cutting enablers for the achievement of all three pillars of sustainable development".[26] Hence, taking into account these changing development priorities, it is clear there is a need to re-evaluate the role of ICT in development.

II. Transformative impacts on society

21. Emerging changes in the digital development landscape, discussed in the first part of the report, are already creating transformative impacts on many facets of our society. This section discusses some of the key transformative impacts of these changes on two important sectors of society, namely, the economy and politics.

A. Digital economy

22. There are attempts to measure the size of the ICT sector or the Internet economy.[27] These estimates indicate that these elements of the digital economy typically represent less than 10 per cent of gross domestic product, even in the more developed economies. These sectors are growing faster than the general economy but the majority of ICT gains are captured by the traditional economy. By looking at the changes associated with ICTs in the economic sphere, two types of change can be identified: incremental transformations that take existing models and improve their coverage or performance, and disruptive transformations that truly harness the power of ICTs to create fundamentally new business models. Each of these will be described in turn.

Incremental transformation

23. A key problem of the poor in developing countries is that they can be excluded from economic opportunities by lack of access to information. ICTs can help overcome such barriers. As well as improving economic opportunities for marginalized groups, ICTs can improve the functioning of existing businesses. They can cut operational costs and expand market reach for all scales of firms, helping them improve their sustainability and profitability. Further, ICTs enable consumers to be part of the production process. For example, a survey among millennials in South Africa revealed that 74 per cent are

[26] Joint Statement of the United Nations Group on the Information Society on the Post-2015 Development Agenda, Geneva, 2013.

[27] OECD, 2008, *The Seoul Declaration for the Future of the Internet Economy*, OECD, Paris, available at http://www.oecd.org/internet/consumerpolicy/40839436.pdf, accessed 19 February 2015. See also McKinsey and Company, 2011, *Internet Matters: The Net's Sweeping Impact on Growth, Jobs, and Prosperity*, McKinsey Global Institute, available at http://www.mckinsey.com/features/sizing_the_internet_economy, accessed 19 February 2015; Boston Consulting Group, 2012, *The Internet Economy in the G-20: The $4.2 Trillion Growth Opportunity*, Boston Consulting Group, Boston, Massachusetts, available at https://www.bcg.com/documents/file100409.pdf, accessed 19 February 2015; OECD, 2013, *Measuring the Internet Economy*, Paris, available at http://dx.doi.org/10.1787/5k43gjg6r8jf-en, accessed 19 February 2015; European Commission, 2014, Digital Economy – Facts and Figures, Expert Group on Taxation of the Digital Economy, European Commission, Brussels, available at http://ec.europa.eu/taxation_customs/resources/documents/taxation/gen_info/good_governance_matters/digital/2014-03-13_fact_figures.pdf, accessed 19 February 2015.

connected with various companies and brands online, and they expect their feedback on various products to be reflected in future product design.[28] ICTs can even change the performance of groups of businesses. Small and medium-sized enterprises have often struggled to grow, but ICTs enable such networks to work together at relatively low cost. This can allow such enterprises in low-income locations to compete, when otherwise they might be driven out of business by large firms.

Disruptive transformation

24. Digital technologies can go beyond incremental transformation and create much greater change that may challenge existing ways of doing business. ICT has facilitated the creation of digitally enabled products through the creation of new digital products and the digitization of existing products. Examples include the conversion of books into e-books, newspapers into news websites and classroom education into e-learning. Similarly, ICT applications in businesses have led to new digital business models. Most digital business models are traditional ways of doing things but with the overlayering of ICT. They come with distinguishing features such as being virtual, open, crowd sourced and shared. One such business model is that of highly profitable information monopolies, where, significant power and control is vested in large ICT firms, compared with their consumers and nation States. At the same time, in some countries, popular ICT applications make certain services, such as hospitality and transportation, more competitive and disrupt the current market dynamics in these sectors. ICT applications have also facilitated cooperative, community-based economic models that can be equally disruptive, as they challenge mainstream ways of doing business. For example, open-source models such as open-source software production are based on a commitment to sharing and open participation among a community of peers. They are only feasible because of the sharing and coordination made possible by ICTs.

B. Digital politics

25. Similarly to the economic realm, the transformative impacts of ICTs on politics can be broken down into the incremental and the disruptive. These transformations in the political realm are facilitated by the strengthening of all types of networks by ICT applications. These networks, which include people, devices and organizations, are fast becoming increasingly complex. Also, these network structures will have less of a physical, and more of a virtual, existence. Millennials and digital natives are playing key roles in these networks and as a result are instrumental in ushering in political changes, as they use ICT as a platform for engaging in public life.

Incremental transformation

26. Many people in developing countries are excluded from fair access to public services. ICTs can help overcome some of these issues by reaching out to low-income communities though e-government and m-government applications. Evidence suggests this can make public services quicker and cheaper to access, for example, by eliminating the need to travel to district headquarters; improve consistency and citizen satisfaction; and significantly reduce corruption. ICTs can also be used to improve government in other ways. Particularly, they can help the voice of the people to be heard in ways they previously were not. With regard to ICT-enabled political campaigns – which may involve

[28] M Mbugua, 2014, Zooming in on the South African millennial, August, available at: http://www.whyweare.co.za/article/millennials, accessed 19 February 2015.

e-petitions but also a broader range of online communication – governments have been pushed to change their legislative programmes and hold politicians more accountable.

Disruptive transformations

27. Digitally enabled social movements give voice to alternative politics. At times, these new social movements have been credited with enacting regime changes.[29] Although the precise role of ICTs in many of the revolutionary movements is debatable, there is general acceptance that some regime changes would not have taken place or at least not in the same manner or timescale, had it not been for ICTs. Similarly, new digital models that empower citizens to a much higher degree are being witnessed. Examples include initiatives such as:

(a) E-accountability: Electronic accountability systems seek to solve problems of corruption or underperformance in government. Online applications are being used by citizens to track performance against politicians' promises, report corruption of public officials, track budget payments to their intended destinations and show which officials handled a licence application;

(b) E-participation: This type of initiative helps people participate in government decisions. Citizens are often highly motivated to engage with such initiatives, and it can change their view of themselves and their governments;

(c) E-collaboration: Citizens can co-produce government goods and services by using ICTs. For example, interactive community mapping has been undertaken in Africa, using community members and others to capture details of roads, buildings and facilities on a digital map.

28. At the opposite end of the spectrum, some digital applications significantly shift power towards governments. For example, some States make use of e-surveillance to gather evidence that is used to repress their opponents. They also actively use ICTs for repressive purposes. As the activities and lives of citizens are increasingly played out online, digital technologies could also allow greater government monitoring and control over citizens.

III. Policy implications of a changing digital development landscape

A. Broadening the ICT for development discourse

29. The ICT4D discourse emerged in the mid-1990s and saw digital ICTs as a useful tool for development. The paradigm arose because of the rough coincidence between general availability of the Internet – a tool in search of purposes – and the Millennium Development Goals – purposes in search of tools. Following the launch of the Goals, ICTs began to be integrated more into development plans and projects as a tool to deliver development. From the development side, this is expressed in national policy portfolios, poverty reduction strategy papers and the United Nations Development Assistance Frameworks. From the ICT side, this is expressed in national ICT policies and action lines of the World Summit on the Information Society.

[29] R Heeks and R Seo-Zindy, 2013, ICTs and social movements under authoritarian regimes: An actor-network perspective, Development Informatics Working Paper No. 51, IDPM, University of Manchester, United Kingdom , available at http://www.seed.manchester.ac.uk/subjects/idpm/research/publications/wp/di/di-wp51/, accessed 19 February 2015.

30. Over the years, the ICT4D discourse has focused on the incremental impacts of technology, such as improvements in the efficiency of microenterprises and better delivery of health or market information. However, this does not encompass the broader, disruptive transformations that ICT is increasingly enabling in our society, as discussed in the previous section. ICT is becoming part of a digital nervous system that fast underpins almost all development activities. As a result, some of the limitations of the initial ICT4D perspective are becoming evident, with clear implications for policymaking. For example, a key policy focus of the ICT4D approach has been the digital divide, with considerable emphasis on those who are not digitally connected. However, it has become increasingly evident that simply focusing on access misses the point. As more areas and people become digitally connected, new divides are emerging in terms of capabilities and resources. Further, the original ICT4D perspective has taken a limited view of ICTs within development policy, seeing them as an assistive add-on to some aspects of that policy. But this view will be out of sync with a world in which ICTs are becoming a pervasive foundation for all aspects of development policy. And, structurally, the initial ICT4D perspective fragments policy responsibilities into silos of many individual development sectors such as health, education and rural development, when coherent policy linking those silos would be necessary.

31. Hence there is an increasing need to broaden the ICT4D discourse so as to incorporate these changing realities into the digital development landscape. The ICT4D discourse should recognize ICT as a platform that increasingly mediates development. In other words, digital technologies need to move from a peripheral role in development to being a central means by which to achieve and experience development.

B. Policy focus areas of digital development

32. To accommodate the changing digital development landscape, it is necessary to expand the ICT4D discourse. This would imply policy interventions in four key areas: the digital ecosystem, digital inclusion, digital sustainability and digital threats. Each of these four policy focus areas will be explored below, with some suggestions for policy interventions.

Digital ecosystem

33. The digital ecosystem can be understood as the space formed by the convergence of the media, telecommunication and information technology industries.[30] Such an ecosystem involves components such as technological infrastructure, data infrastructure, financial infrastructure, institutional infrastructure and human infrastructure. The digital ecosystem provides the inputs necessary to create the technical foundations, and social and technical applications required for effective digital development.[31] The private sector may not invest adequately in all components of digital ecosystems, as ecosystem investments are a type of public goods characterized by the inability of the investor to capture all the returns on investment. Policy intervention is therefore required to set up an efficient digital ecosystem.

[30] World Economic Forum, 2007, *Digital Ecosystem Convergence between IT, Telecoms, Media and Entertainment: Scenarios to 2015*, Geneva, available at http://www3.weforum.org/docs/WEF_DigitalEcosystem_Scenario2015_ExecutiveSummary_2010.pdf, accessed 19 February 2015.

[31] R Heeks, 2014, *ICT4D 2016: New Priorities for ICT4D Policy, Practice and WSIS in a Post-2015 World*, Development Informatics Working Paper No. 59, IDPM, University of Manchester, United Kingdom, available at http://www.seed.manchester.ac.uk/subjects/idpm/research/publications/wp/di/, accessed 19 February 2015.

However, such public intervention should not merely aim to increase public investment, but rather aim to create incentives for private sector investment and ensure their involvement, wherever possible. The dynamism, power and resource access of the private sector needs to be harnessed and should be a driving force for digital development.

34. A first step towards strengthening any national digital ecosystem would include an audit of the current digital ecosystem to identify particular areas of weakness. Policy interventions should orient multiple channels of finances towards strengthening the weaker components of the digital ecosystem. One of the key objectives of State policy should be to ensure a pervasive high-capacity, interoperable technological and data infrastructure. This would involve policy interventions by enabling regulatory policies, making direct investments, building public–private partnerships and setting quality standards. This should be accompanied by a supportive legal and institutional infrastructure that promotes digital innovation capabilities at ground level.

35. Most importantly, the human infrastructure needs to be strengthened in terms of ICT production and consumption capabilities, including complementary capabilities such as communication, and interpersonal and analytical skills. These complementary capabilities are essential in converting ICT skills to productive employment opportunities. This calls for educational policy interventions at primary, secondary and tertiary educational and vocational training levels. Focus should also be on how to empower people to emerge as innovators and producers of ICT applications suited for specific local needs.

Digital inclusion

36. ICT can empower people. At the same time, however, lack of digital access and inadequate digital capabilities can exacerbate inequalities in society. Digital development is based on networks. In this context, three groups can be clearly distinguished: "the haves", who have access to all required resources and skills; the "have-nots", who are completely cut off from any direct benefits of ICTs; and the "have-lesses", who are often prevented from deriving maximum benefits from digital development.[32] Most of the millennials of the global South can be classified as digital have-lesses. For example, the millennials in several African countries, though exposed to opportunities offered through various online hosting platforms, find it increasingly difficult to make use of them because their domestic banking system has not yet been integrated into global payment gateways.[33] Also, digital inequality tends to reflect the existence of other inequalities in society in terms of employment, education and income, based on subgroups such as gender[34] and ethnicity. These inequalities can be worsened by the lack of appropriate local content in ICT applications.

37. In this context the linkage between ICT and gender inequality merits special attention. Women are 23 per cent less likely to use the Internet in low-to-medium income countries, while in sub-Saharan Africa, this gap widens to 43 per cent.[35] This access divide

[32] M Castells, 2010, *The Information Age: Economy, Society, and Culture*, second edition, Wiley-Blackwell, Chichester, United Kingdom.

[33] V Counted, 2014, We are connected, but constrained: Internet inequality and the challenges of millennials in Africa as actors in innovation, Third Millennium Africa Project, conference paper: second International Conference on Innovation and Entrepreneurship, University of Bangkok, Thailand.

[34] M Hilbert, 2011, Digital gender divide or technologically empowered women in developing countries? A typical case of lies, damned lies, and statistics, *Women's Studies International Forum*, 34 (6), 479–489, November-December, available at http://dx.doi.org/10.1016/j.wsif.2011.07.001, accessed 19 February 2015.

[35] Intel, Dalberg Global Development Advisors and Globescan, 2012, *Women and the Web: Bridging the Internet Gap and Creating New Global Opportunities in Low and Middle-income Countries*,

can exacerbate the existing gender inequality of development outcomes and leave women further behind. At the same time, ICT could be a game changer in terms of empowering women, if supported by adequate policy interventions to overcome gender-specific barriers. Therefore, attaining gender parity with regard to digital access and digital capabilities should be a special focus of ICT policies, especially in developing countries.

38. Inclusive digital development does not merely imply providing access to ICT; it also implies improving access to complementary resources and obtaining capabilities that enable digital access to be turned into development results. The full digital ecosystem should be extended to encompass excluded groups of society. It is important that the digital ecosystem audit proposed earlier should also identify dimensions of digital exclusion, as well as the key constraints faced by such excluded groups. Policy interventions should aim to create incentives to promote inclusive digital innovations. ICT capability building of marginalized groups should be a top priority. Community-based capacity-building initiatives tailored to local needs could help in this regard. Policy interventions must also incentivize local ICT innovation and development capacities within developing countries that can create inclusive data, local content and inclusive applications.

Digital sustainability

39. The linkages between ICTs and sustainability can be understood in terms of the level or order of the impacts.[36] The physical existence of ICT sectors have direct impacts on sustainability, but through numerous applications in non-ICT sectors, ICT can substantially contribute towards improving sustainability in an indirect manner. The reduction in carbon emissions due to smart grids and the automation of the power sector can be considered indirect applications. In addition, ICT also creates behavioural and societal changes. Their aggregate impacts will have transformative impacts on sustainability that are relevant not only to the environment, but also to economic prosperity and social equity. For example, changes in consumption patterns triggered by ICT usage have vast sustainability implications. Further, ICT also has the potential to help improve the resilience of systems. There is therefore a need for a holistic approach that takes on board all these multiple linkages of ICT and sustainability, while planning policy interventions.

40. In terms of policy interventions, encouraging sustainability initiatives within ICT sectors and ensuring adequate recycle and disposal facilities for e-wastes can help reduce considerably the direct environmental impacts of ICT. The indirect positive impacts of ICT can only be realized through capacity-building measures and creating an enabling environment for smart applications in non-ICT sectors. Governments should also encourage research on the behavioural and aggregate impacts of ICT on society and the resultant sustainability implications. Applications of ICT to improve resilience of development subsystems need to be facilitated.

Santa Clara, California, United States, Intel Corporation, available at http://www.intel.com/content/dam/www/public/us/en/documents/pdf/women-and-the-web.pdf, accessed 19 February 2015.

[36] This framework was proposed by the European Union Forum for the Future in 2002 and is further explained in D Souter and D MacLean, 2012, *Changing our Understanding of Sustainability: The Impact of ICTs and the Internet*, International Institute for Sustainable Development, December, 2012, available at http://www.iisd.org/sites/default/files/pdf/2012/changing_our_understanding_of_sustainability.pdf, accessed 19 February 2015.

Digital threats

41. Digital development outcomes vary from jurisdiction to jurisdiction in terms of their legality but that are regarded in many contexts as problematic and as potential threats to society. It has been found that cybercrime incurs economic, political and social costs. The extent of problems caused by gambling[37] and pornography is exacerbated online. ICT sometimes becomes a platform to perpetrate violence against women and girls. Further, the intersection between human rights and the digital world has given rise to several instances of human rights curtailment. While there are some benefits attached to ICT-related monopolies, they also pose challenges such as raising barriers to entry, predatory pricing, invasions of privacy and tax avoidance.[38]

42. Policy measures to fight cybercrime would involve strengthening cybersecurity agencies and spreading awareness of cybercrime. Appropriate legislation should be adopted to ensure that universal human rights are respected online as much as offline. The threats associated with online pornography and gambling also call for effective policy interventions, which may involve appropriate legal measures suited for different national contexts. It is important to develop mechanisms to combat the use of ICT and social media to perpetrate violence against women and girls, including the criminal misuse of ICT for sexual harassment, sexual exploitation, child pornography and trafficking in women and girls, and emerging forms of violence such as cyberstalking, cyberbullying and privacy violations that compromise the safety of women and girls.[39] Greater support for "open development" activities[40] could potentially challenge the monopolistic and proprietary models of ICT activities.

C. Digital development policy governance

43. To encourage effective digital development, more than new policy content is necessary. Policymakers must also consider the governance of digital development policy, especially the structures through which digital development policy is made. During the pre-digital era, the structural approach to ICT policy has been sidestreaming, that is to say, locating ICT policy in a single specialist body, generally a government ministry with one or more of the following in its title: "information", "communications" and "technology".

44. The ICT4D perspective aims to encourage countries to mainstream ICT policies, that is to say, to shift or develop responsibilities for ICT-related policy within other

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[37] RJ Williams, RT Wood and J Parke, 2012, History, current worldwide situation, and concerns with Internet gambling, in *Routledge International Handbook of Internet Gambling*, RJ Williams, RT Wood and J Parke, eds, Routledge, Abingdon, United Kingdom, 3–26.

[38] DS Evans, 2008, Antitrust issues raised by the emerging global Internet economy, *Northwestern University Law Review Colloquy*, 102:285–306, available at http://www.law.northwestern.edu/journals/lawreview/Colloquy/2008/13/LRColl2008n13Evans.pdf, accessed 19 February 2015; KL Levine, 2008, Preserving competition in multi-sided innovative markets, *North Carolina Journal of Law and Technology*, 10(1), 59–117, available at http://www.ncjolt.org/sites/default/files/Devine_Kristine_v10i1_59_118.pdf, accessed 19 February 2015.

[39] United Nations, The elimination and prevention of all forms of violence against women and girls: Agreed conclusions, Commission on the Status of Women, Fifty-seventh session, 4–15 March 2013, available at http://www.un.org/womenwatch/daw/csw/csw57/CSW57_agreed_conclusions_advance_unedited_version_18_March_2013.pdf, accessed 19 February 2015.

[40] ML Smith, L Elder and H Emdon, 2011, Open development: A new theory for ICT4D, *Information Technologies and International Development*, 7(1), iii-ix.

ministries. The need for mainstreaming becomes even greater as countries continue to give ICTs a more central role in their development policies. Hence, every ministry would be involved in policy for digital development, which encourages pervasive mainstreaming of ICT policy in the future. However, there are several problems with mainstreaming.[41] These include a lack of adequate understanding of ICTs within mainstream ministries, and fragmentation and incoherence of digital policy across sectors. Therefore, following up on the aforementioned digital-ecosystem approach, it becomes clear that a holistic understanding and allocation of responsibilities is necessary, as shown below.

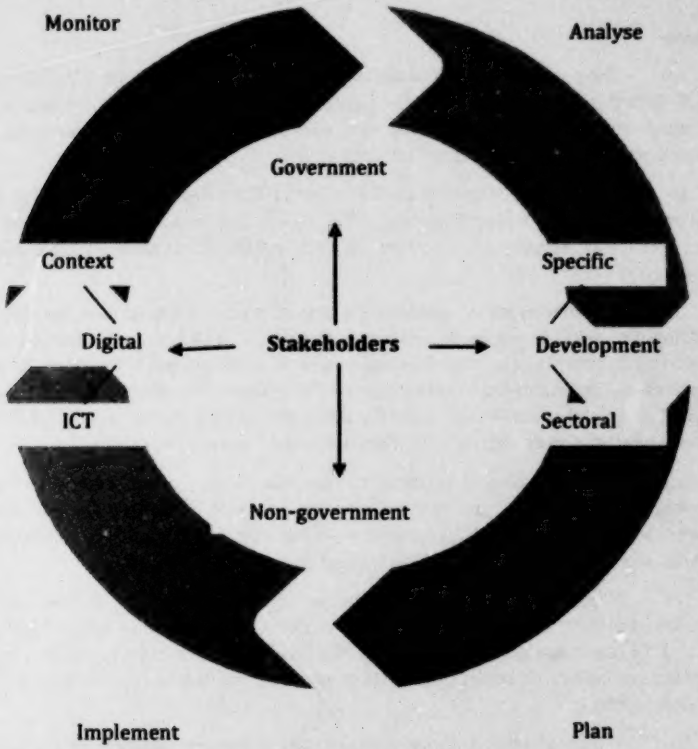
Digital development policy responsibilities

Policy actors	*Policy responsibilities*
Core ICT policy (e.g. ministry of ICT)	Technical and data elements of digital ecosystem, inclusion, sustainability, threats policies
Contextual policy (e.g. ministries of finance, enterprise, trade and industry, education, science and technology)	Broader aspects of digital ecosystem and digital inclusion policies: finance, capabilities, digital processes, business development, innovation
Specific policy	Particular aspects of particular policies, e.g. digital inclusion (ministry of community development); digital sustainability (ministry of environment); digital threats (ministry of information and media; ministry of trade and industry)
Sectoral policy (e.g. ministries of agriculture, health, education, finance, enterprise, public administration, national security)	Sectoral aspects of digital ecosystem policy promoting transformative ICT application
International policy (e.g. United Nations and other supranational bodies)	Cross-national aspects of digital ecosystem, inclusion, sustainability, digital threat policies
Business strategy (e.g. leading, transnational digital corporations)	Recognition that business strategies of key digital corporations form part of the policy system
Civil society	Informing the government about the needs of society, weak links in the digital ecosystem, specific issues related to digital inclusivity, sustainability and managing digital threats.

45. To ensure the effective allocation of responsibilities, a cross-cutting collaborative structure may need to be created. As shown in figure 2, this structure will perform a dual bridging role, horizontally drawing in policy actors from both ICT and development; and vertically, those connected with government and other sectors. Indeed, experiences with various types of ICT policy suggest the value and merits of autonomous and capable State agencies, combined with strong representative bodies for both the private sector and civil society, and a mechanism for robust interaction between these three groups.

[41] R Heeks, 2010, Mainstreaming ICTs in development, *ICT4DBlog*, 30 October, available at http://ict4dblog.wordpress.com/2010/10/30/mainstreaming-icts-in-development-the-case-against/, accessed 19 February 2015.

Figure 2
Collaborative structure for digital development policy



46. Governments may seek to develop a single collaborative structure for all areas of digital development policy. However, this could become unwieldy, given that digital activity extends to every area of government responsibility. It may be advisable to consider structures along the main policy focus areas, such as the digital ecosystem, inclusion, sustainability and threats. Special attention should be given to convergence issues, in order to ensure coherence in policy. For example, ministries of finance and ICT will need to work together on the implications of m-money and e-money becoming the basis for financial and banking transactions; ministries of employment and ICT will need to work together on the implications of how best to generate jobs for the millennials and digital natives, and to identify in advance sectors that will lose jobs due to ICT applications in the future. Further, ministries of education and ICT will need to work together on the increasing digital mediation of learning.

47. It is important to adopt an experimental and iterative approach to digital development policy, allowing incremental learning and policy revision. The Commission should continue to provide a forum for the sharing of good practice experiences and lessons learned in digital development policymaking.

IV. Findings and suggestions

48. This section summarizes the findings presented above and proposes a set of key issues for consideration by the Commission on Science and Technology for Development.

Findings

(a) The potential of ICTs as cross-cutting enablers of sustainable development is not well embedded in the post-2015 development agenda discussions. References to ICTs are limited and inadequate within the outcome documents of Rio+20 and the Open Working Group on Sustainable Development Goals;

(b) There is a need to broaden the current ICT4D discourse to give ICTs a more central role in the development process. ICTs should not be seen merely as tools that achieve particular aspects of development, but rather as a platform that mediates development;

(c) TV white space or momentarily unused spectrum applications have potential in bridging the digital divide by ensuring broadband rural Wi-Fi access in many countries. They also could contribute to generating jobs in areas such as disaster response, smart city applications and environmental monitoring. While regulatory measures are currently being developed in several countries to enable the development of TV white space applications, regulatory inertia in many countries impedes wider application of this technology;

(d) Next-generation small satellites provide an easy access route to space for developing countries, as they are easy to build and relatively inexpensive. These satellites have applications in areas such as agriculture monitoring, climate change mitigation and adaptation, disaster response, weather monitoring and rescue operations;

(e) While the ICT access divide has been narrowing with the increased penetration of mobile technology, the divide in terms of capabilities has been widening. As a result, ICTs can create and also exacerbate the inequalities that exist in society. Further, inadequate availability of appropriate local content on the Internet can hinder inclusive digital development;

(f) A well-developed digital ecosystem is a primary requirement for effective digital development and the facilitation of transformative impacts in society through ICTs. Recognizing and reinforcing the linkages between different components of the digital ecosystem and strengthening its weaker components is crucial;

(g) ICTs are an essential means to unleash and channel the potential of millennials and digital natives towards sustainable development processes. Although the majority of millennials in developing countries use ICT applications, they lack digital innovation capabilities to emerge as entrepreneurs and producers using ICTs;

(h) While ICTs have some direct negative impacts on environmental sustainability through the creation of e-wastes, they also have the potential to promote environmental sustainability indirectly through their application in other sectors and by improving the resilience of the entire ecosystem;

(i) The increased use of ICTs facilitates risks associated with digital threats such as the curtailment of human rights, cybercrimes, gambling, pornography and the creation of monopolies. Millennials are particularly vulnerable to such threats;

(j) The cross-cutting nature of digital policies calls for the creation of collaborative structures for digital policy that involve all relevant stakeholders in order to ensure policy coherence and effectiveness.

Suggestions

49. The Commission is encouraged to take the following steps:

(a) Inform the post-2015 development agenda process on the need for a more central role of ICTs as an enabler and means of achieving the sustainable development goals, through substantive inputs to relevant processes and bodies within the United Nations;

(b) Provide a forum for sharing best practices in terms of developing national and regional regulations and incentive mechanisms to facilitate the application of new emerging technologies such as TV white space applications and next-generation small satellites, in bridging the digital divide and promoting sustainability;

(c) Act as a repository of best practices in policy measures to enhance digital innovation capabilities, particularly of millennials in developing countries, in order to enable them to make best use of the opportunities offered by ICTs;

(d) Collect evidence on how ICTs facilitate collaboration between millennials from developed and developing countries to tackle complex developmental challenges and further undertake research on how best to facilitate such collaboration;

(e) Play an active role in creating awareness about the need to conduct digital ecosystem audits in developing countries and act as a forum to share best practices of digital ecosystem audit methodologies.

50. Member States are encouraged to consider the following suggestions:

(a) Collaborate with all relevant stakeholders, develop regulations and initiate pilot projects that will facilitate the wider application of emerging technologies such as TV white space (momentarily unused spectrum) and next-generation small satellites, giving special attention to their potential to ensure digital inclusion and sustainability;

(b) Bring ICTs to the core of national and international development agendas by recognizing their cross-cutting enabling role in attaining the sustainable development goals;

(c) Conduct audits of national digital ecosystems to identify weaknesses and make effective policy interventions to strengthen the weaker components of the digital ecosystem, while recognizing the interlinkages between its diverse components;

(d) Mobilize and direct financial resources through multiple channels, including crowdfunding and public–private partnerships, to strengthen ICT infrastructure, including human resources capabilities, in developing countries;

(e) Encourage the creation of collaborative structures for digital development policy that will help bring together different stakeholders to create coherent policies to deal effectively with different focus areas of digital policies, such as promoting digital inclusion and digital sustainability, strengthening the digital ecosystem and limiting digital threats;

(f) Use ICTs to create channels that engage millennials in the implementation process of national development agendas and the attainment of the sustainable development goals;

(g) Through appropriate primary, secondary and higher educational and vocational training policies, enhance the digital innovation capabilities of citizens, along with complementary skills such as analytical ability, communication and interpersonal skills;

(h) Encourage a community-based approach to ICT capacity-building, especially by providing platforms for the younger digital natives to share their knowledge of ICTs and train their community in ICT usage;

(i) Take adequate policy interventions and spread awareness to limit threats related to ICT usage such as cybercrime, gambling, pornography, the curtailment of human rights and the creation of monopoly power in ICT services;

(j) Encourage the development of local content on the Internet and other ICT applications as a means to ensure digital inclusion and bridge the content divide;

(k) Collaborate with all relevant stakeholders, promote the application of ICTs in non-ICT sectors to improve environmental sustainability and ensure the creation of suitable facilities to recycle and dispose of e-waste.